



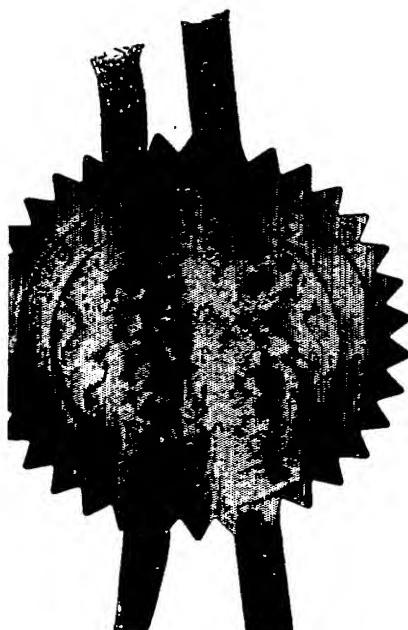
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Dated 11 January 2005

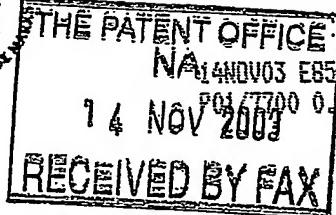
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Patents Form 1/77

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*(The Patent Office will fill this part in)***0326597.2**3. Full name, address and postcode of the or of each applicant (*underline all surnames*)

The Technology Partnership PLC
Melbourn Science Park
Cambridge Road
Melbourn
Royston
Hertfordshire
SG8 6EE

Patents ADP number (*if you know it*)

If the applicant is a corporate body, give the country/state of its incorporation

(GB) **06754345001**4. Title of the invention
A SYSTEM5. Name of your agent (*if you have one*)

"Address for service" in the United Kingdom to which all correspondence should be sent
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i.p. 21 Limited
Norwich Research Park
Colney
NORWICH
NR4 7UT
United Kingdom (GB)

Patents ADP number (*if you know it*)**08182446001**

6. Priority: Complete this section if you are declaring priority from one or more earlier parent applications, filed in the last 12 months.

Country

Priority application number
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7. Divisionals, etc: Complete this section only if this application is a divisional application or resulted from an entitlement dispute (see note 5)

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8. Is a Patents Form 7/77 (Statement of inventorship and of right to grant of a patent) required in support of this request?

Answer YES if:

- a) any applicant named in part 3 is not an inventor, or
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- c) any named applicant is a corporate body.

Otherwise answer NO (See note 4)

YES

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Continuation sheets of this form: 0

Description: 8 ✓

Claim(s): 0

Abstract: 0

Drawing(s): 2 ✓

M

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Priority documents

Translations of priority documents

Statement of inventorship and right to grant of a patent (Patents Form 7/77)

Request for a preliminary examination and search (Patents Form 9/77)

Request for a substantive examination (Patents Form 10/77)

Any other documents (please specify)

11. I/We request the grant of a patent on the basis of this application.

Signature(s)

ip21 limited by tB

Date 14/11/2003

12. Name, daytime telephone number and e-mail address, if any, of person to contact in the United Kingdom

Ian Bishop

01603 457008

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- 1 -

A SYSTEMField of the Invention

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The invention relates to laser marking systems.

Prior Art known to the Applicants

20

US 6075223 discloses a prior art method of laser marking for metal, plastics, ceramics substrates using sensitive inks (one prior art example of sensitive inks being microencapsulated inks). This prior art document was selected as useful background to the present invention because it teaches the use of a single laser energy source adapted to emit a wavelength which in this prior art document is destined to be absorbed by the ink to create a bond between the ink and the substrate at the irradiated points.

25

Other prior art examples of single laser marking systems are those incorporating carbon dioxide lasers. The applications of this technology have taken place primarily for date and lot coding on production lines. In one particular application a single CO₂ laser is used in combination with a special substrate containing both ink and paper. In this prior art application, the laser supplies sufficient energy to cause the paper to be visibly marked.

Prior art laser marking systems broadly have the following drawbacks;

- 5 ▪ CO₂ laser systems are limited by their size and can therefore not easily be scaled down to provide a compact source;
- 10 ▪ Arrays of CO₂ cannot be created and require an additional scanning system to scan the laser beam;
- 15 ▪ They are also complex systems with a high unit cost;
- 20 ▪ One main drawback of these prior art systems is their relatively slow achievable speed of marking;
- 25 ▪ Another prior art drawback is their relatively high power consumption.

The objectives of the present invention include introducing a system which offers significant advantages over this prior art teaching, by reducing the overall cost of marking systems, making a more compact and serviceable system, enhancing the speed of printing, reducing the individual laser power requirement and reducing the overall cost of marking by reducing the unitary cost of the substrate required to be employed by the system.

Another objective of the present invention is to propose alternative solutions to the drawbacks and problems associated with the prior art discussed above, all forming part of the single inventive concept of 'improvements to laser marking systems transmitting light onto one or a plurality of points on a sensitive substrate'.

Summary of the Invention

- 30 In a first broad independent aspect, the invention provides a laser marking system comprising means for transmitting the laser-emitted light onto one or a plurality of points on a substrate, with means for displacing the substrate and laser light emitting source relative to one another, wherein the substrate is selected to be sufficiently sensitive to the

emitted light so that a reaction occurs at either said point or plurality of points which marks the substrate and characterised by the feature that the laser light emitting source comprises an array of lasers.

- 5 This configuration is advantageous because it achieves greater compactness, has greater reliability, is more serviceable whilst utilising lower levels of power and achieving higher speed of marking and being altogether low cost. It is particularly advantageous because the use of a laser array may achieve simultaneous multiple point marking. This will contribute to reducing the time required to mark the substrate. In this configuration, each
10 laser may also be individually addressed which may allow different levels of pigmentation marking for different pixels to be substantially simultaneously marked onto the substrate. Furthermore, the paper costs may be kept to a minimum.

In a second broad independent aspect, the invention provides a laser marking system,
15 comprising an array of lasers, which in use, emit light, means for transmitting the emitted light onto one or a plurality of points on a substrate, means for displacing the substrate and said array relative to one another, and a heater whose primary function is to heat the substrate prior to radiating the substrate so that the energy required to be supplied by the array of lasers for marking the substrate is minimised.

20 This configuration will be particularly beneficial because it will have the effect of reducing the necessary laser power required to cause a reaction on the substrate during the marking process. One specific benefit of this configuration is that it allows relatively low sensitivity paper substrate to be marked with relatively low power lasers, thus reducing
25 the paper and system costs. A further advantage of this configuration is that it will allow enhanced time marking speeds to be achieved in certain applications.

In a subsidiary aspect in accordance with the invention's second broadest aspect, the heater employs a heat exchanger for transferring the heat generated by the array of lasers
30 to the substrate.

In a further subsidiary aspect in accordance with any of the broad independent aspects, the system further comprises means for varying the energy supplied to each point of the substrate by varying over time the pulse and/or amplitude of the transmitted light so that a
5 scale of mark's pigmentation may be achieved.

This configuration has particular benefits for achieving so-called grey-scale markings on substrates.

10 Brief Description of the Figures

- Figure 1 shows schematically a side elevation of a laser marking system in accordance with a first embodiment of the invention.
15 Figure 2 is a schematic representation in side elevation of a laser marking system in accordance with a second embodiment of the invention.

Figure 3 is a further schematic representation in side elevation of a laser marking system in accordance with a third embodiment of the invention.

20

Detailed Description of the Figures

The term 'heat exchanger' employed in this application is destined to be interpreted broadly for example by including within its scope passive heat exchangers and active heat
25 exchangers such as heat pumps.

Figure 1 shows a laser marking system generally referenced 1. Laser marking system 1 comprises a substrate 2 drawn from a roll 3 by a pair of drive wheels 4 and 5. Substrate 2 is located immediately beneath a laser array 6 incorporating a number of individually
30 addressed elements (not specifically illustrated in the figure). The light emitted by the laser array 6 is transmitted to substrate 2 via a lens 7 spaced between the laser array and the substrate in order to focus the light transmitted onto a point on the substrate.

Upstream from the laser array 6, there is provided a pre-heating bar 8 located in proximity to the substrate in order to transfer thermal or optical energy to the substrate so that as the substrate approaches the laser array it is close to its marking threshold. The geometry of the pre-heating bar may be designed to cover the width of the substrate. The pre-heating
5 bar may take a variety of forms such as a resistive heater incorporating heating elements operating by conduction or radiation, or optical sources heating by absorption of optical radiation.

The heating characteristics of the bar may also be tailored to particular applications, for
10 example by providing higher or lower heating energy where greater heat loss is predicted at certain points of the substrate due to the substrate's position in the system, its environment, its geometry and/or its material characteristics.

Laser array 6 may be selected by the person skilled in the art from known alternatives
15 which may include semi-conductor laser diode arrays. The energy in the laser light will be selected so that when absorbed by the paper it causes a chemical reaction which results in a mark.

It is also envisaged that the laser array may incorporate only a reduced number of laser
20 elements associated with means for controlling the lateral position on a substrate that the laser spot is focused onto. This may be achieved, for example, by mechanical motion of optical elements, by electronically switchable diffractive elements or by branched wave guides with switching components (such as Mach-Zehnder Interferometers).

25 The optical transmission means referred to above as 7 may comprise a single lens or a more complex array of micro lenses, wave guides, graded-index lenses, diffractive optical elements or even reflectors.

The substrate may be selected by the person skilled in the art to be a paper which reacts to
30 laser light: primarily optically, primarily chemically or photo-chemically, and/or thermally including thermal initiation and/or any combination and/or sequence of these reactions. In one preferred form it is envisaged that the paper and the laser will be

respectively selected to radiate in the infra red spectrum and react chemically or optically in the infra red spectrum.

Figure 2 shows a laser marking system generally referenced 9 where, for simplicity, 5 components which are similar to those employed in the illustration of Figure 1 have retained the same numerical references. The primary addition to the configuration presented in Figure 1 is the addition of a heat pump 10 which allows the heat exchange between laser array 6 and pre-heater 8. In a similar fashion, other waste heat in the system say from the drive electronics may be used in the pre-heater. The person skilled in 10 the art may, for example, select a thermo-electric device as a heat pump placed between the laser and the pre-heater to improve the heat transfer efficiency.

Identical components have preserved identical references in Figure 3 which shows a laser marking system generally referenced 11. If the marking mechanism is photo-chemical in 15 nature, the pre-heating concept described with reference to either preceding figures may be used to enhance or speed up the reaction. An alternative method for use with photo-chemical reactions is to utilise optical biasing where a bright uniform light source such as that shown and referenced 12 in Figure 3 is used to illuminate the paper substrate to add a base level of light required to achieve the optical density just below the marking 20 threshold. The laser array is shown to be emitting light on the paper at the same position as the bright uniform light source. This additional light source may be selected by the person skilled in the art to be, for example, a discharge lamp or a laser as convenient.

Any non-linear nature of the paper also offers the opportunity of reducing the paper 25 threshold. The energy required to mark the paper is dependent on the time over which that energy is applied. The non-linearity may be optical or thermal in origin. One example of thermal non-linearity would be in the conduction over time of heat away from the spot on the paper on which the laser is incident. One example of optical non-linearity would be in the absorption of photons over time. The system envisages the incorporation 30 of control means which will allow many adjustments to be made to fine tune its operation with respect to these kinds of non-linearity. The person skilled in the art may also select for example the use of specific papers to address specific non-linearities – for example

he/she may select a paper with relatively low thermal conductivity in the case of thermal non-linearity.

The key limitation on the optical output power of the laser array is the thermal load that it generates which requires removing the heat from the laser which can be achieved by passive or optionally active cooling means. One preferred approach is to provide control means which switch the laser on at a high power but for a short limited time. In this manner the thermal load remains the same on the laser but the paper is unable to conduct the incident heat away as quickly, hence creating more efficient marking.

Furthermore, a method to still achieve the speed of the print with higher threshold paper is to provide the system with means which increase the spacing between the marked points on the paper. For example, printing at a pitch of 100 microns but only marking with a laser spot size of 50 microns. If the paper is selected to be highly thermally-insulating, this will result in spaces between the marks and a reduced opacity of the print. This may be acceptable for some applications, eg. receipt printing.

The invention also envisages means for varying the energy supplied to each point of the substrate by varying the pulse and/or amplitude of the transmitted light so that a scale of mark's pigmentation may be achieved. By employing pulse duration or amplitude modulation, the present system may be particularly suited for grey-scale marking.

The invention also envisages, although the cost of such technology is still considerable, the use of specialized semiconductor heat pumps such as Peltier coolers adapted to act as a heat exchanger between the laser array and a section of the paper substrate upstream from the laser array.

Whilst the first two embodiments present the use of a heater to supplement thermal energy prior to the substrate being submitted to the laser array and the third embodiment presents the use of a laser array in conjunction with an optical biasing light source, the system may optionally be configured as a hybrid of both these embodiments where the substrate is pre-heated and radiated by a biasing light source in addition to the radiation from the laser array.

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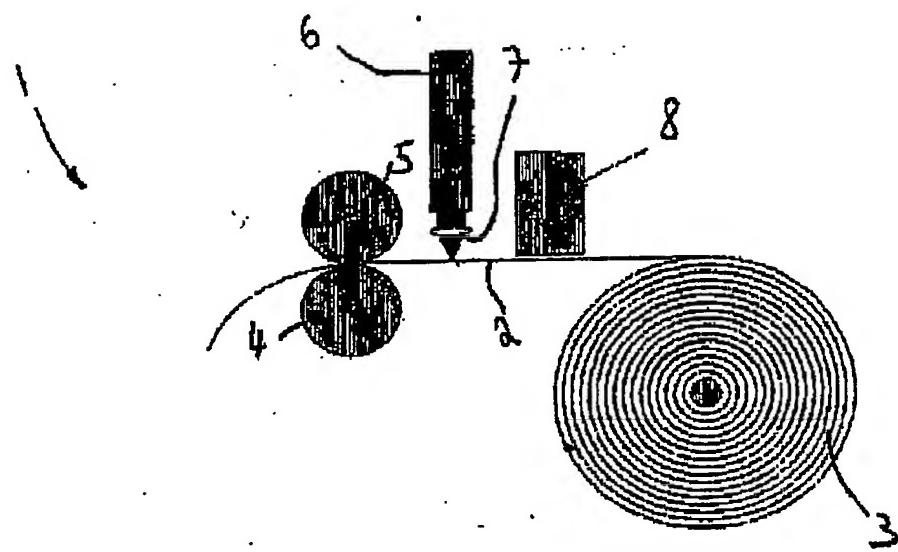
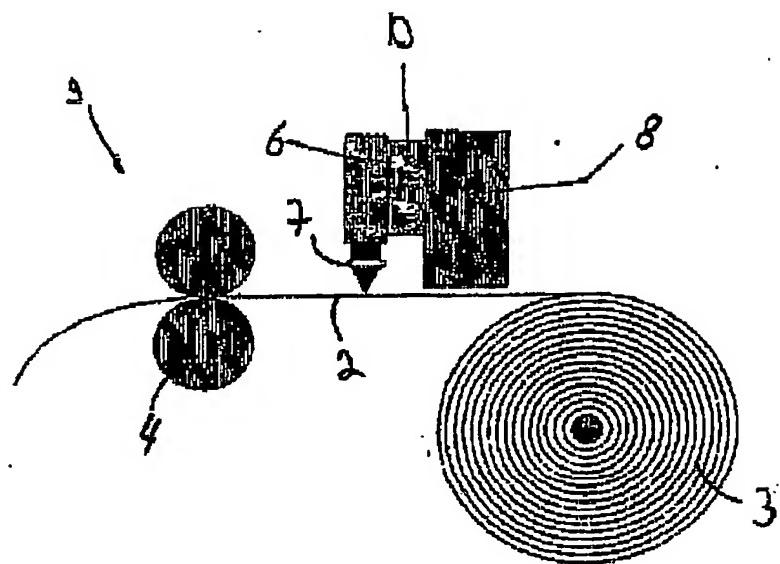
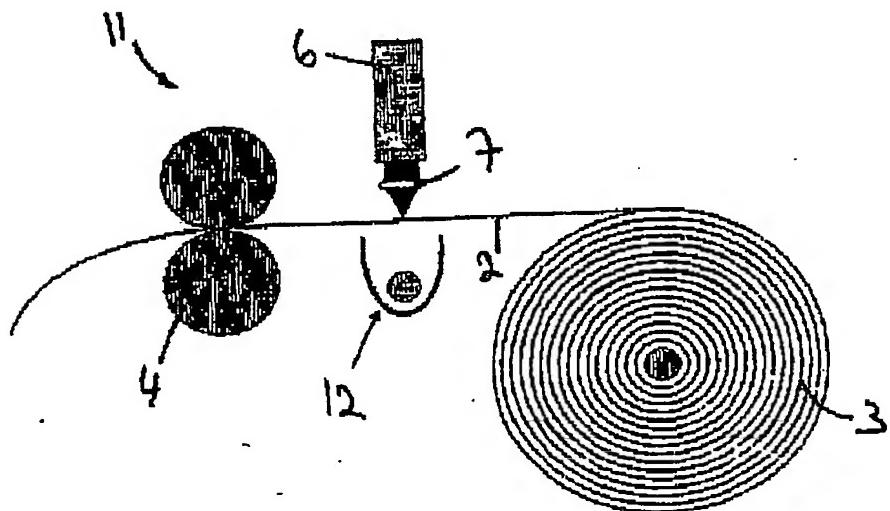


FIGURE 1

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FIGURE 2FIGURE 3

Document made available under the Patent Cooperation Treaty (PCT)

International application number: PCT/GB04/004808

International filing date: 15 November 2004 (15.11.2004)

Document type: Certified copy of priority document

Document details: Country/Office: GB
Number: 0326597.2
Filing date: 14 November 2003 (14.11.2003)

Date of receipt at the International Bureau: 20 January 2005 (20.01.2005)

Remark: Priority document submitted or transmitted to the International Bureau in compliance with Rule 17.1(a) or (b)



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